City of Santa Barbara

Sea Level Rise Adaptation Plan for the Local Coastal Program Update – Subcommittee Meeting 2

August 8, 2017

Photo Courtesy of Michael Theis

Presentation Outline

- Basics of sea-level rise
- Santa Barbara future sea-level rise projections
- Coastal hazards with future sea-level rise
- Hazard modeling
- Hazard mapping

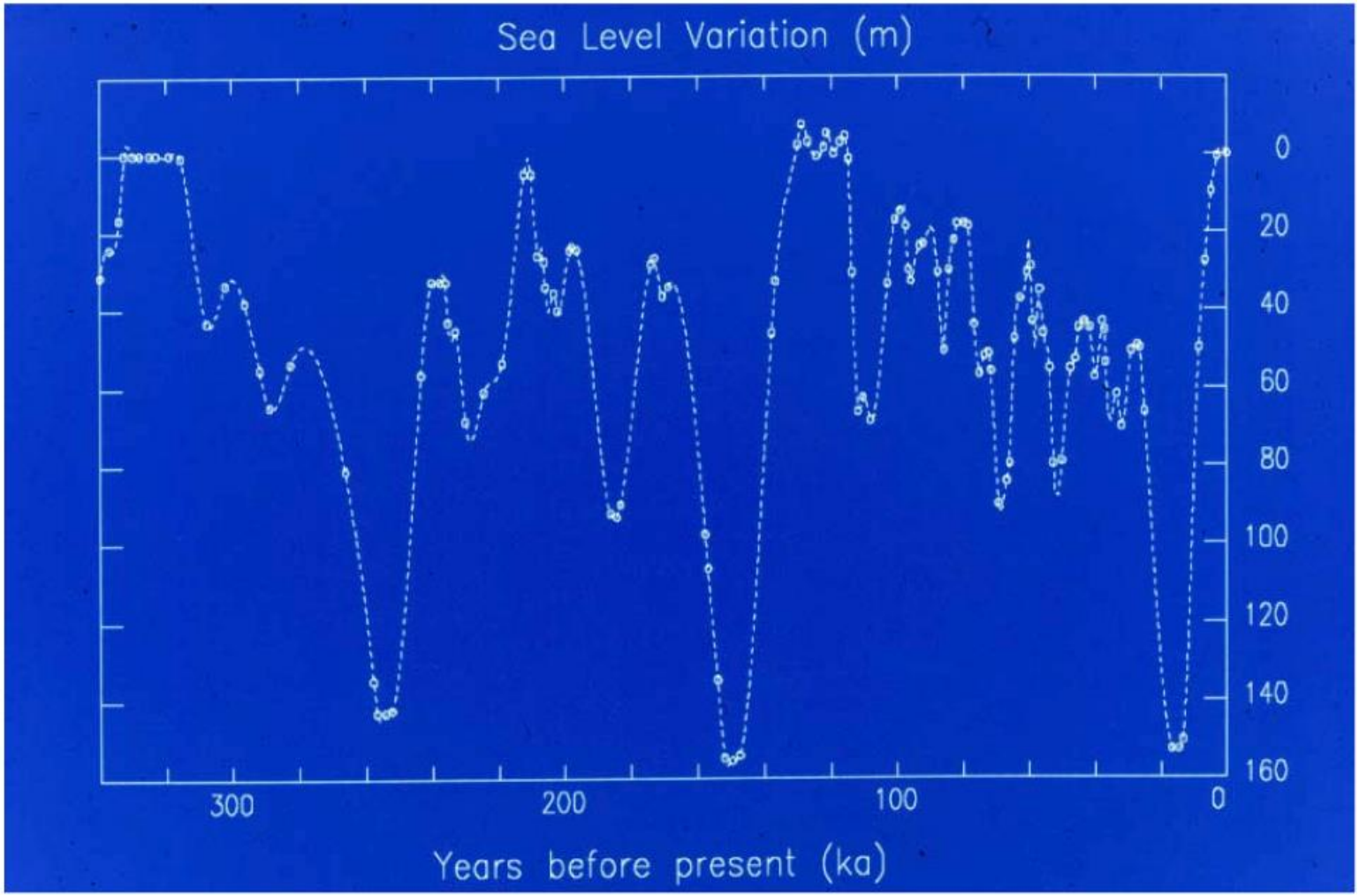
Next meeting: Vulnerability Assessment

Subcommittee's Questions

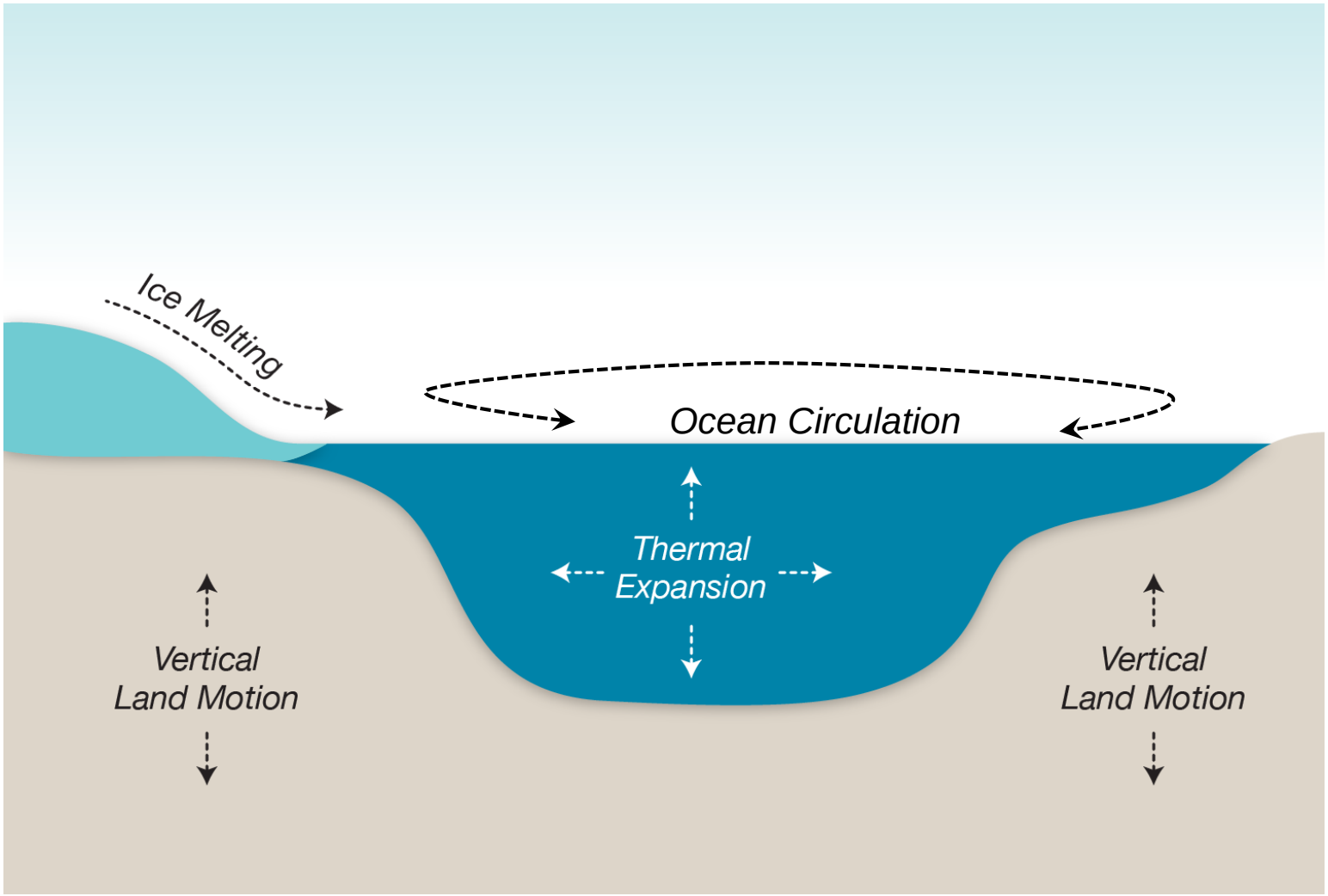
- Is the amount of sea level rise we are looking at just a worst case scenario?
- How are we deciding which level of sea level rise to use?
- What's the likelihood of these happening?
- Has the State decided what to use or did we decide?
- If we decided a portion of it, what did we base our decision on?

Sea Level – The Past 300 Thousand Years

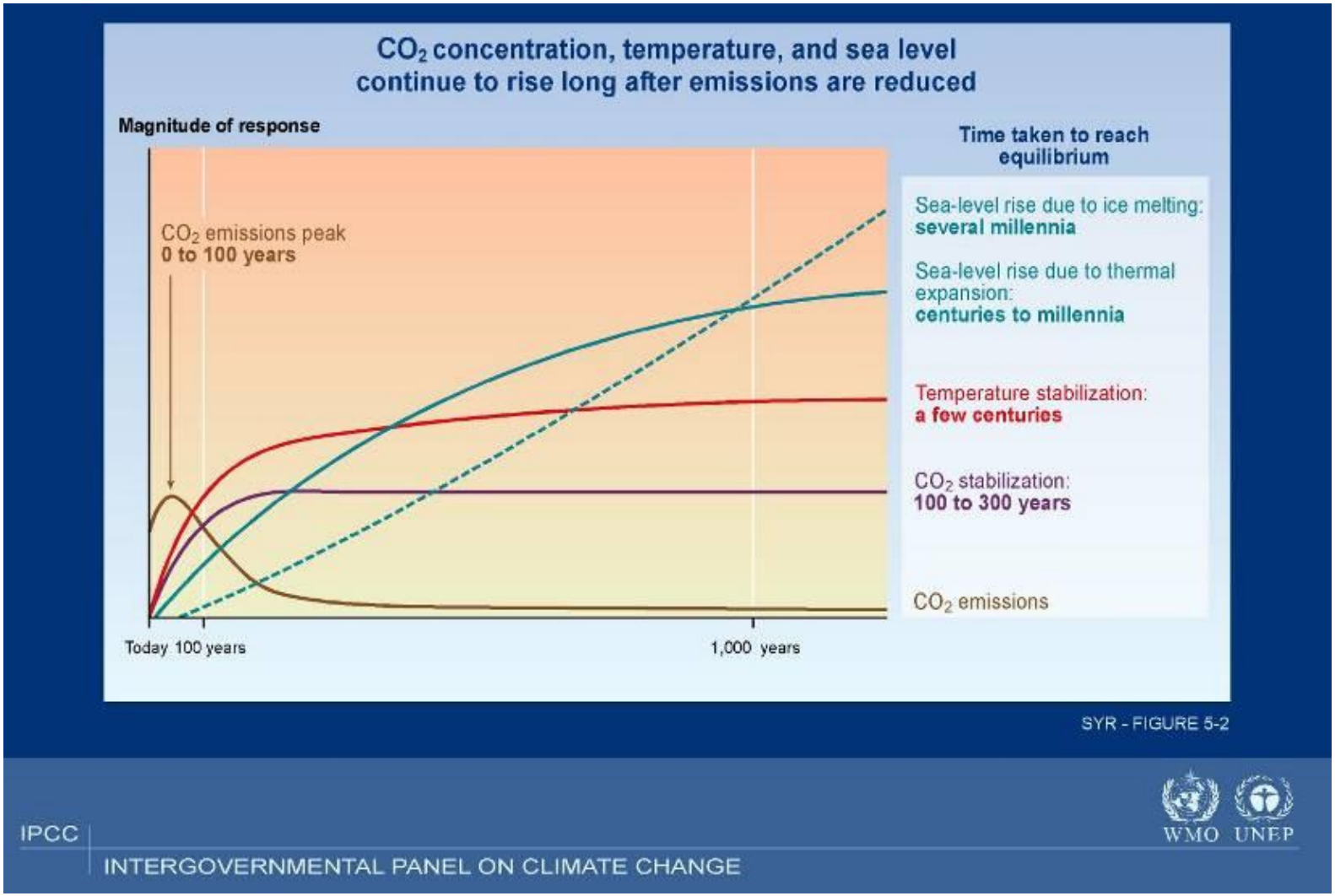
Sea level was about 500' lower about 15,000 – 20,000 years ago, and has been "steady" for last 5,000 to 6,000 years



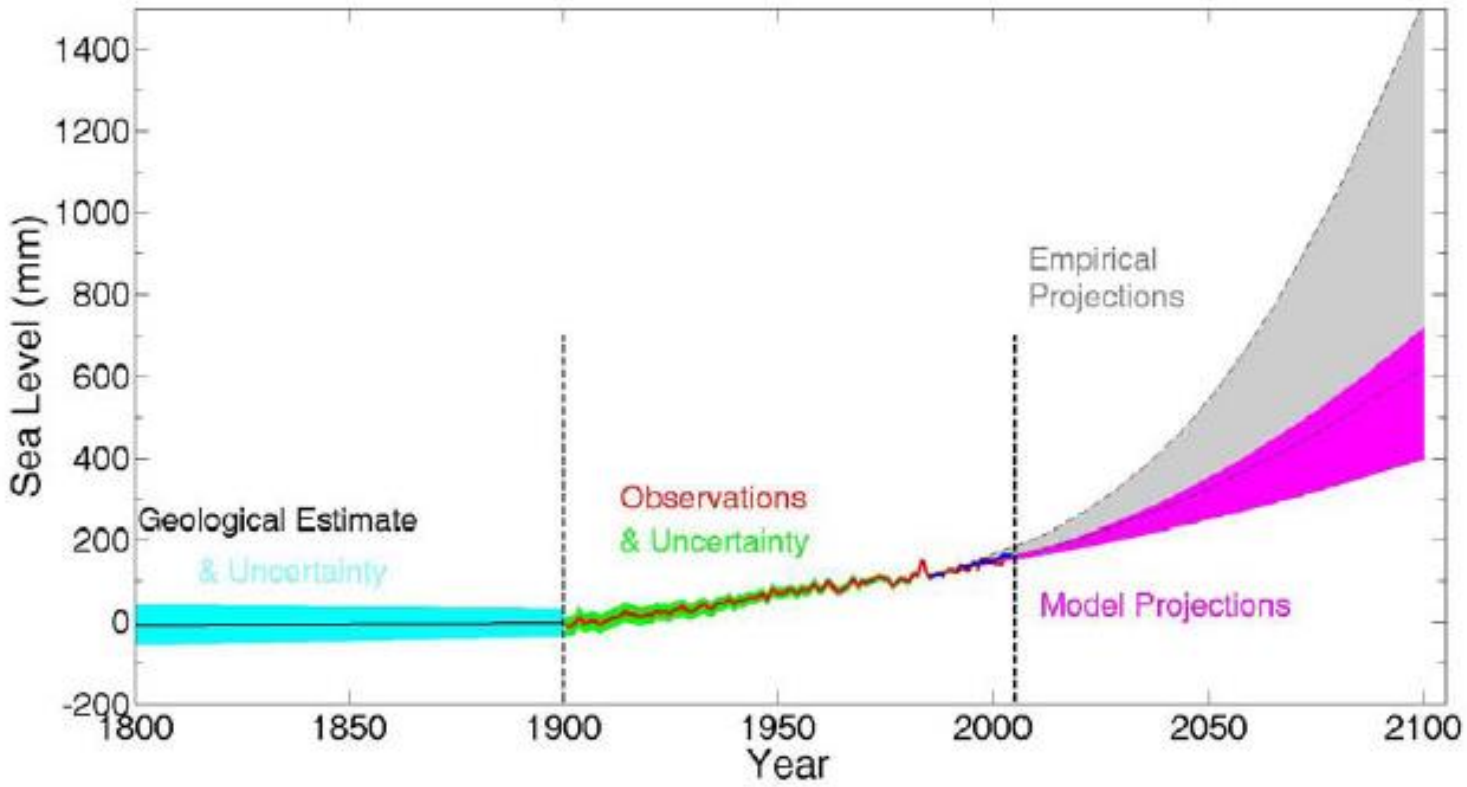
Factors Affecting Rates of SLR



Time Scales of Climate Change Impacts



Historic and Projected Sea Level Rise

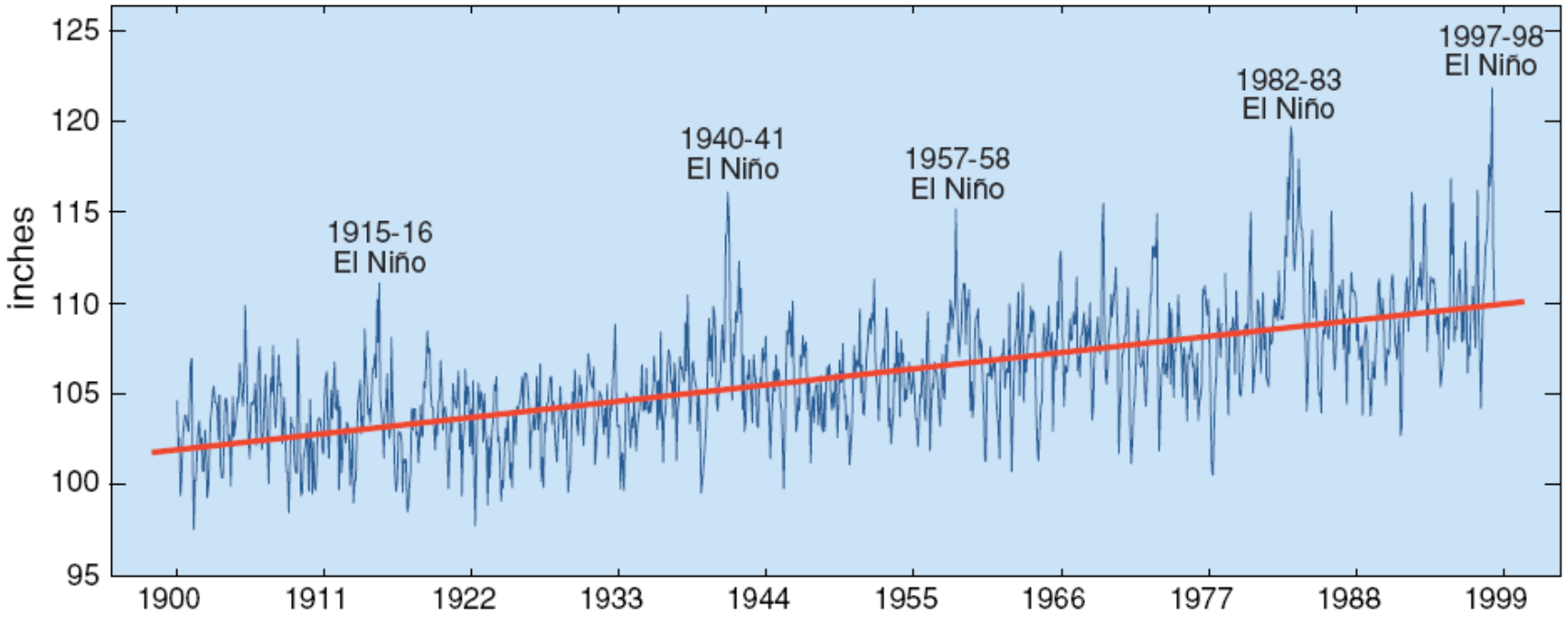


1.7mm/yr – between 1900 and 1992

3.1 mm/yr – between 1992 and Present

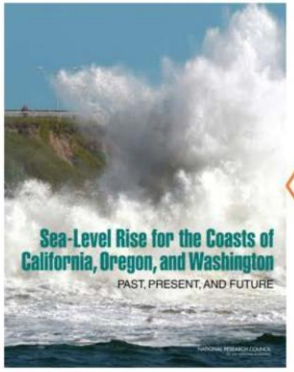
Sea Level Rise Example: San Francisco

- Rate of sea level change 2.17 mm yr (about 8 inches in last 100 years)
- Higher than global average (1.5-2 mm yr) because of local subsidence
- Driven by Thermal Expansion, and Ice Melt
- Punctuated by Large Storm events

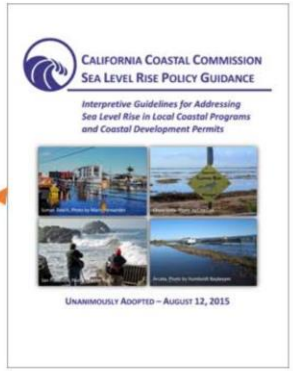


CA SLR Science and Guidance Documents

NRC 2012



CCC 2015

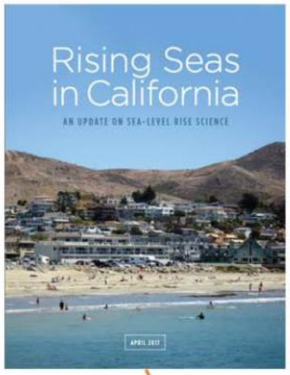


OPC 2013

State of California Sea-Level Rise Guidance Document

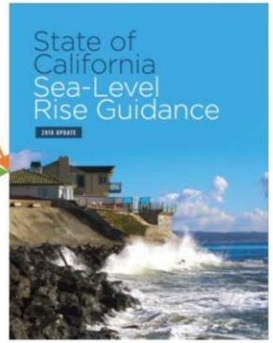
March 2013 Update

Griggs et al 2017



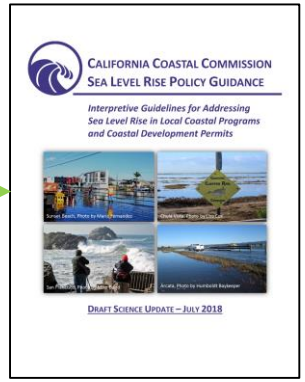
Updated March 2018

OPC 2018



July 2018 Draft Update

CCC 2018 Draft



New Sea-Level Rise Guidance from OPC and CCC (2018)

Ocean Protection Council (OPC 2018)

- Tables for 12 tide gages in California
- Risk-based

CA Coastal Commission (CCC 2018 Draft)

Recommends:

- High Emissions Projections
- Med-High risk aversion projection for community-based LCP updates
- Extreme (H++) risk aversion projection for critical infrastructure projects

SLR Guidance for SB (OPC 2018)

		Probabilistic Projections (in feet) (based on Kopp et al. 2014)				H++ scenario (Sweet et al. 2017) *Single scenario
		MEDIAN	LIKELY RANGE		1-IN-20 CHANCE	1-IN-200 CHANCE	
		50% probability sea-level rise meets or exceeds...	*66% probability sea-level rise is between...*		*5% probability sea-level rise meets or exceeds...*	*0.5% probability sea-level rise meets or exceeds...*	
				Low Risk Aversion		Medium - High Risk Aversion	Extreme Risk Aversion
High emissions	2030	0.3	0.2 -	0.4	0.5	0.7	1.0
	2040	0.5	0.3 -	0.7	0.8	1.1	1.6
	2050	0.7	0.4 -	1.0	1.2	1.8	2.5
Low emissions	2060	0.7	0.4 -	1.0	1.4	2.2	
High emissions	2060	0.9	0.6 -	1.3	1.6	2.5	3.6
Low emissions	2070	0.9	0.5 -	1.3	1.7	2.8	
High emissions	2070	1.1	0.7 -	1.7	2.1	3.3	4.9
Low emissions	2080	1.0	0.5 -	1.5	2.0	3.6	
High emissions	2080	1.4	0.9 -	2.1	2.7	4.3	6.3
Low emissions	2090	1.1	0.6 -	1.8	2.4	4.4	
High emissions	2090	1.7	1.1 -	2.6	3.3	5.3	7.9
Low emissions	2100	1.2	0.6 -	2.0	2.9	5.3	
High emissions	2100	2.1	1.2 -	3.1	4.1	6.6	9.8
Low emissions	2110*	1.3	0.7 -	2.1	3.0	5.9	
High emissions	2110*	2.2	1.4 -	3.2	4.2	6.9	11.5
Low emissions	2120	1.4	0.7 -	2.4	3.5	7.0	
High emissions	2120	2.5	1.7 -	3.7	4.9	8.2	13.7
Low emissions	2130	1.5	0.8 -	2.6	3.9	8.0	
High emissions	2130	2.9	1.8 -	4.2	5.6	9.5	16.0
Low emissions	2140	1.6	0.8 -	2.9	4.4	9.1	
High emissions	2140	3.1	2.0 -	4.8	6.4	11.0	18.6
Low emissions	2150	1.8	0.7 -	3.2	5.0	10.5	
High emissions	2150	3.5	2.2 -	5.3	7.2	12.6	21.4

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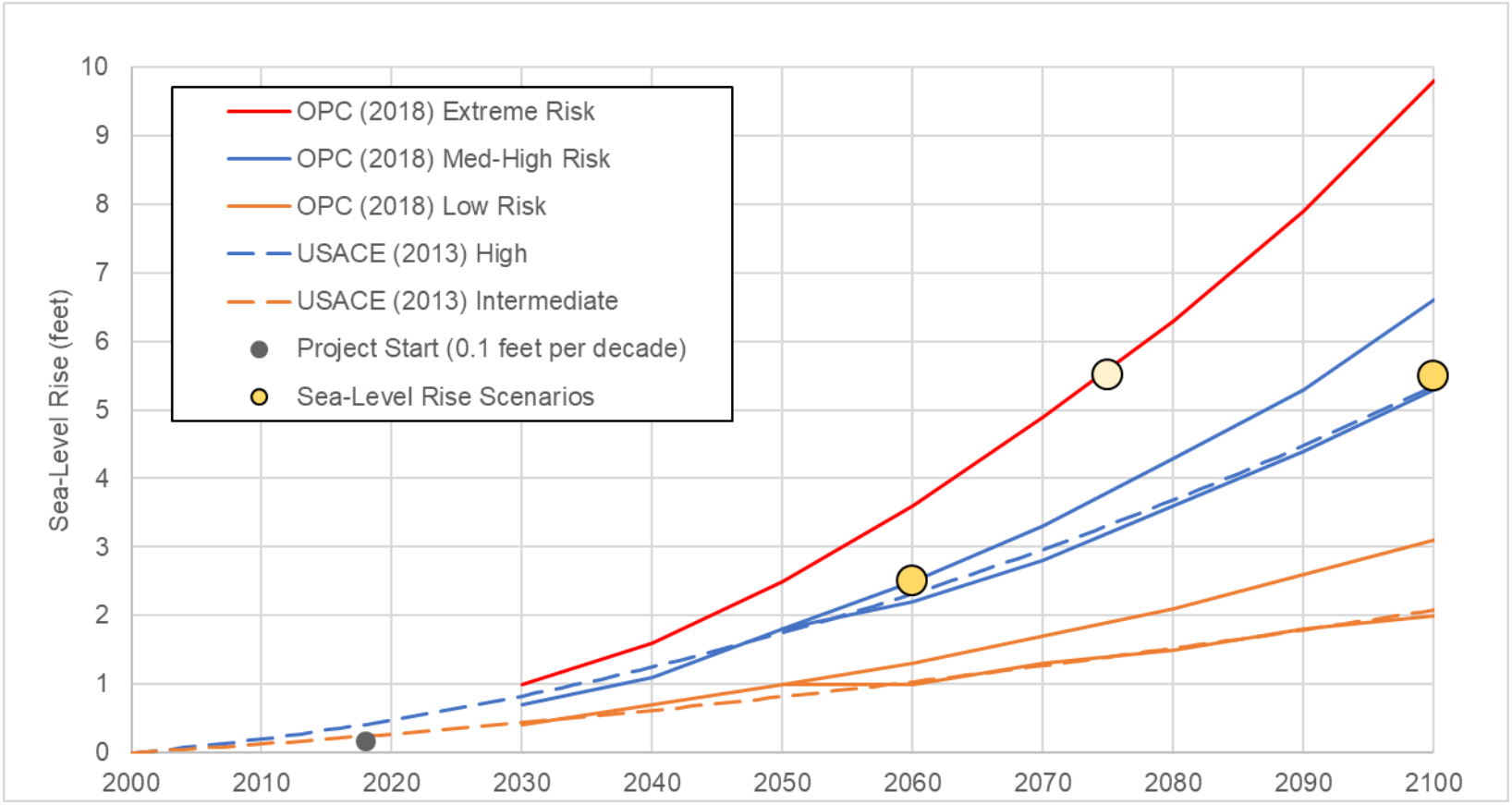
Scenarios for Santa Barbara SLR Adaptation Plan Compared to State and Federal Guidance on SLR



Hazard Types and Impact Class

Hazard Type	Impact Class
Erosion (bluff or shoreline)	Permanent, complete loss
Tidal Inundation	Permanent, complete loss
Storm Waves	Temporary, damages
Storm Flooding	Temporary, damages
Flood-prone / Low-lying	Temporary, damages

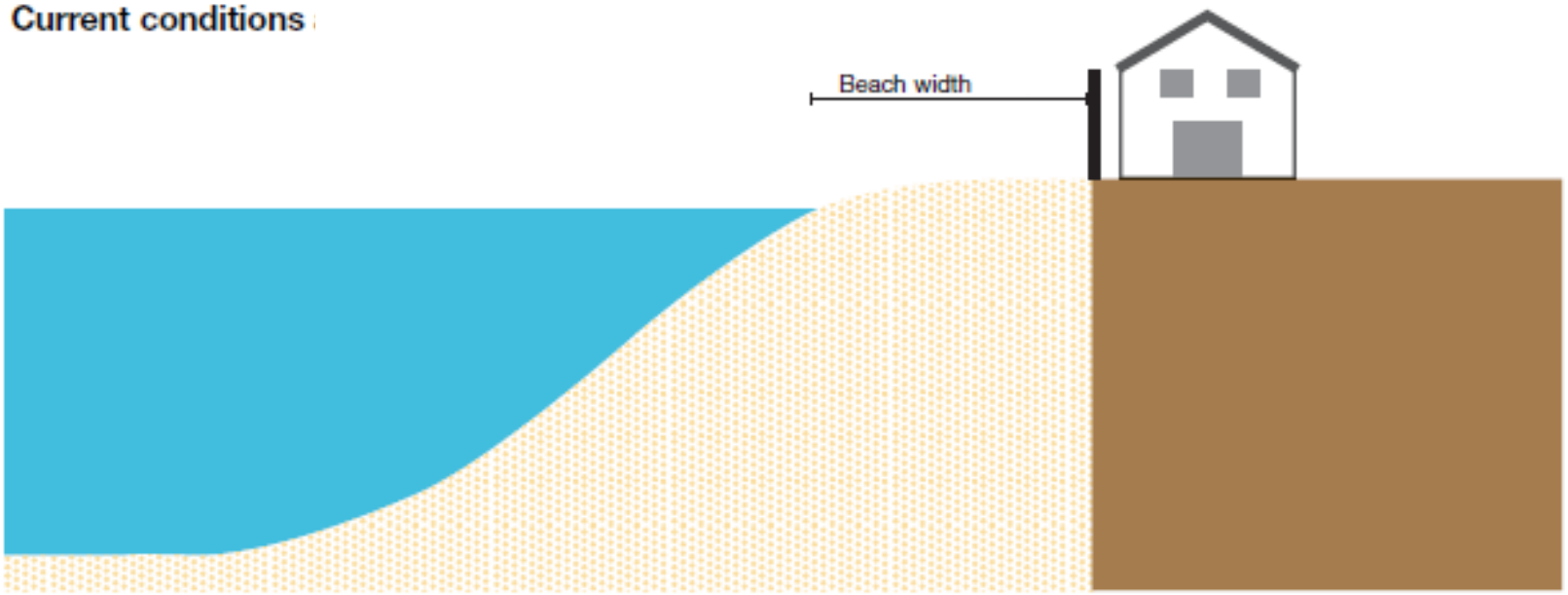
Bluff Erosion

Bluff Erosion

Bluff Erosion

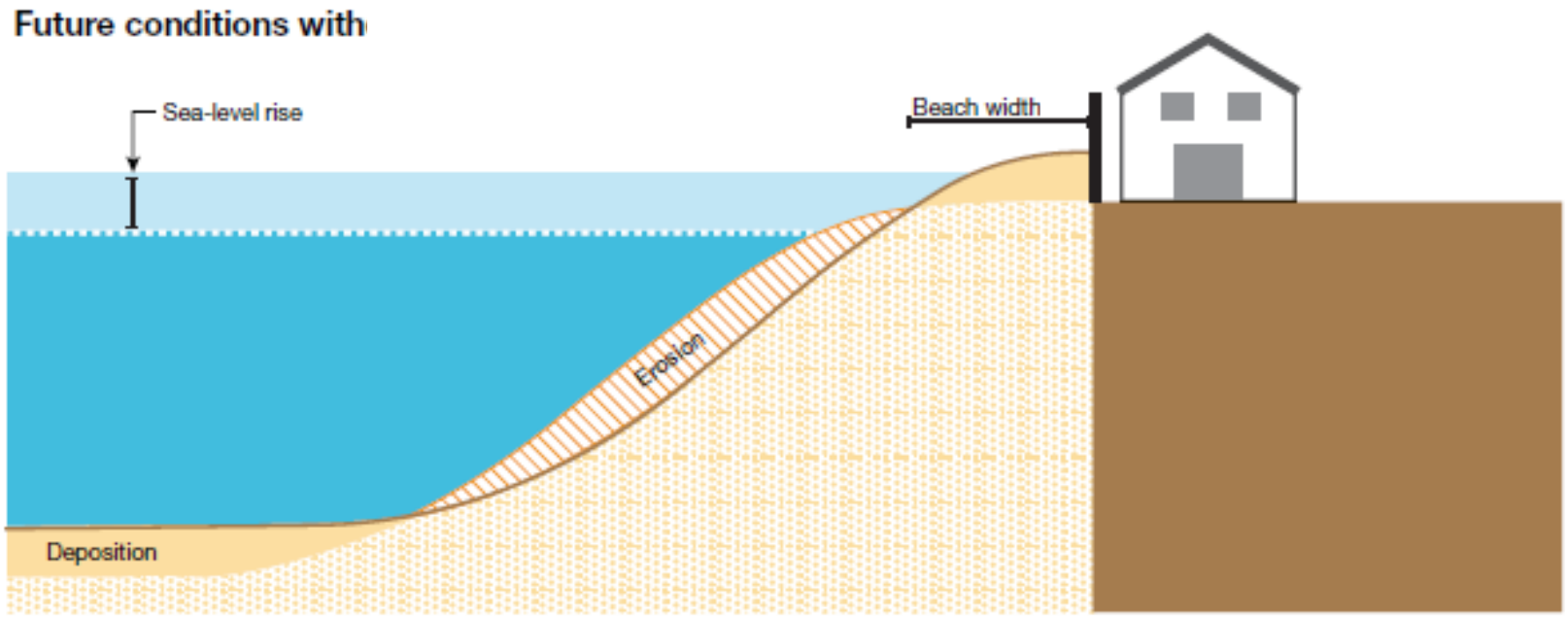
Shoreline Erosion

Shoreline Erosion



- Existing beach profile

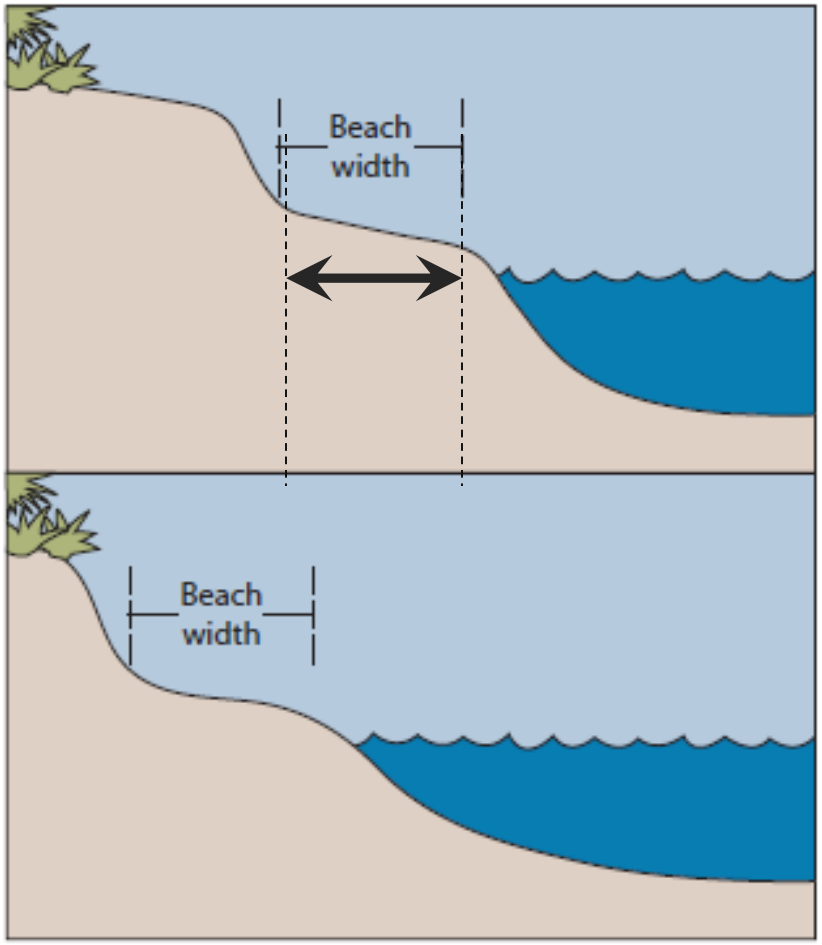
Shoreline Erosion



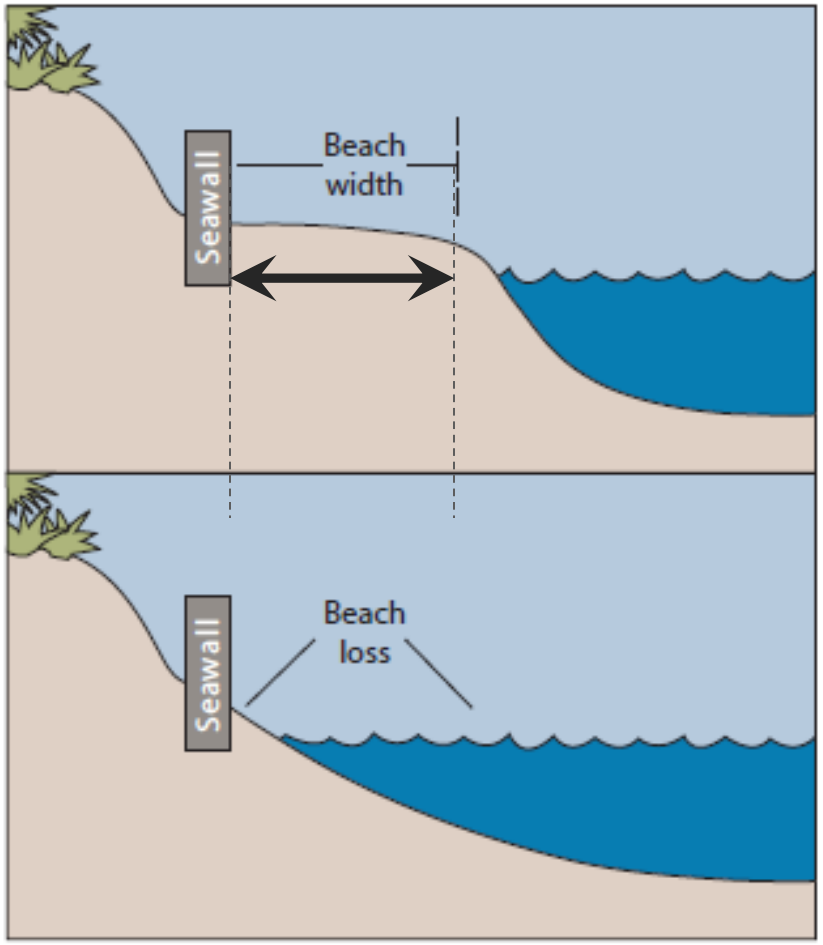
- Beach erodes with sea-level rise

Shoreline Erosion – Beach Loss with Armoring

Normal Beach Retreat



Blocked Beach Retreat



Tidal Inundation

Storm Waves

Storm Waves

Storm Flooding

Flood Prone / Low-Lying

Coastal Hazard Model Results

- U.S. Geological Survey (USGS) Coastal Storm Modeling System (CoSMoS) ourcoastourfuture.org
  - Bluff erosion
  - Shoreline (beach) erosion
  - Tidal inundation
  - Storm flooding (“100-year” storm event)
- Coastal Resilience, Santa Barbara County (ESA) maps.coastalresilience.org/california/
  - Storm waves (“100-year” storm event)
  - Flood prone / low-lying

Coastal Hazard Maps

1. **By hazard**
2. By scenario

Tidal Inundation

Existing, 2060, 2100

Tidal Inundation

Existing, 2060, 2100

Storm Flooding

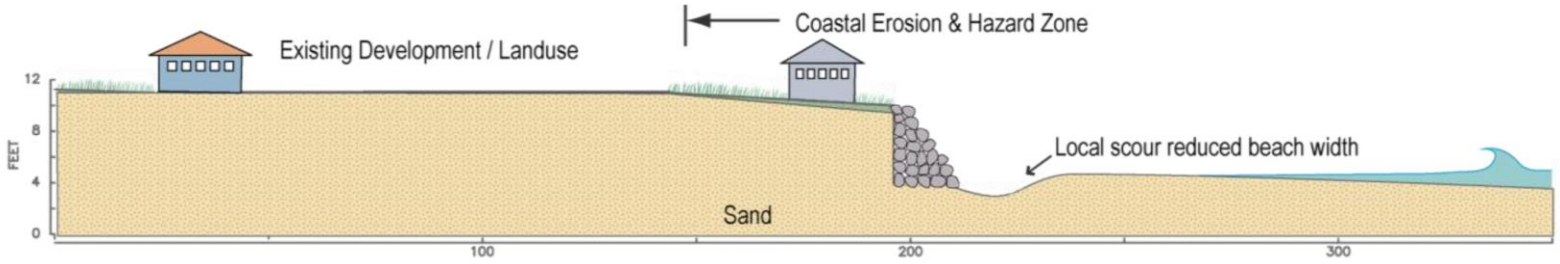
Existing, 2060, 2100

Storm Flooding

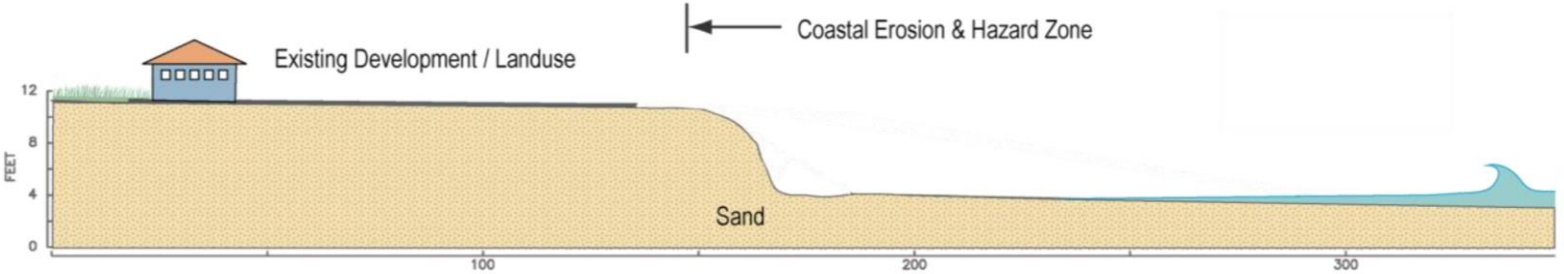
Existing, 2060, 2100

Shoreline Erosion: “Hold the line” vs. “Let it go”

- CoSMoS “Hold the Line” scenario assumes that armoring would be maintained and erosion would stop at armoring



- CoSMoS “Let it Go” scenario assumes that armoring fails/erodes and is not replaced, and erosion continues landward of armoring



Cliff and Shoreline Erosion

Existing, 2060, 2100

Cliff and Shoreline Erosion

Existing, 2060, 2100

ESA

Beach Loss – Initial Assessment

Narrow, bluff-backed beaches (Arroyo Burro, Douglas Family Preserve, Shoreline Park)

- Dry beach (above wave runup at high tide) lost by 2060 with 2.5 ft of SLR
- Damp beach (wetted by waves and tide most days) lost or reduced to a minimum by 2100 with 5.7 ft of SLR

Wider beaches (East Beach, Leadbetter Beach, West Beach)

- Dry beach reduced to ~1/3 current width by 2060 with 2.5 ft SLR and lost by 2100 with 5.7 ft of SLR
- Damp beach (~40 ft width) persists to 2100 with 5.7 ft SLR

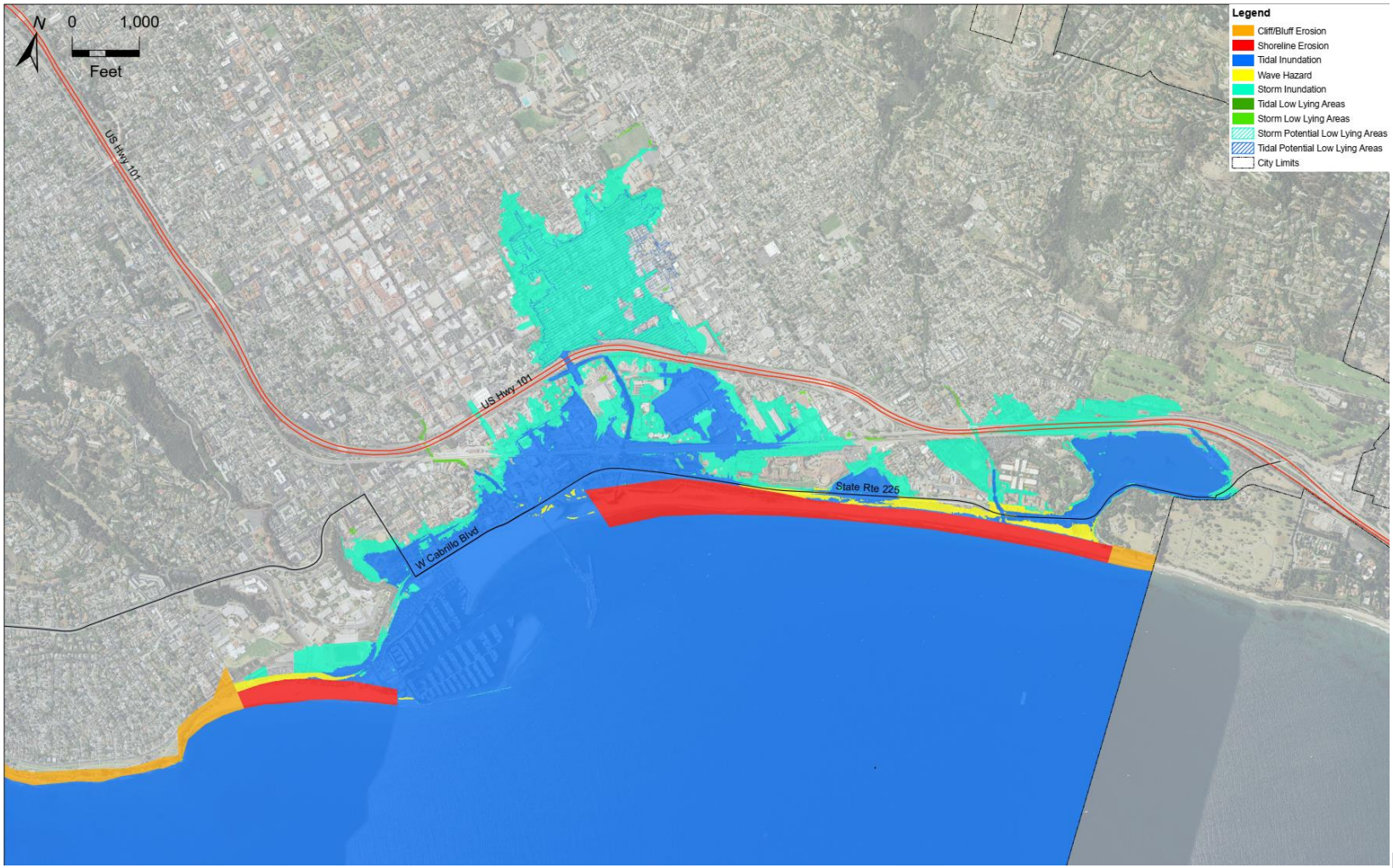
Coastal Hazard Maps

1. By hazard
2. **By scenario**

Existing Conditions

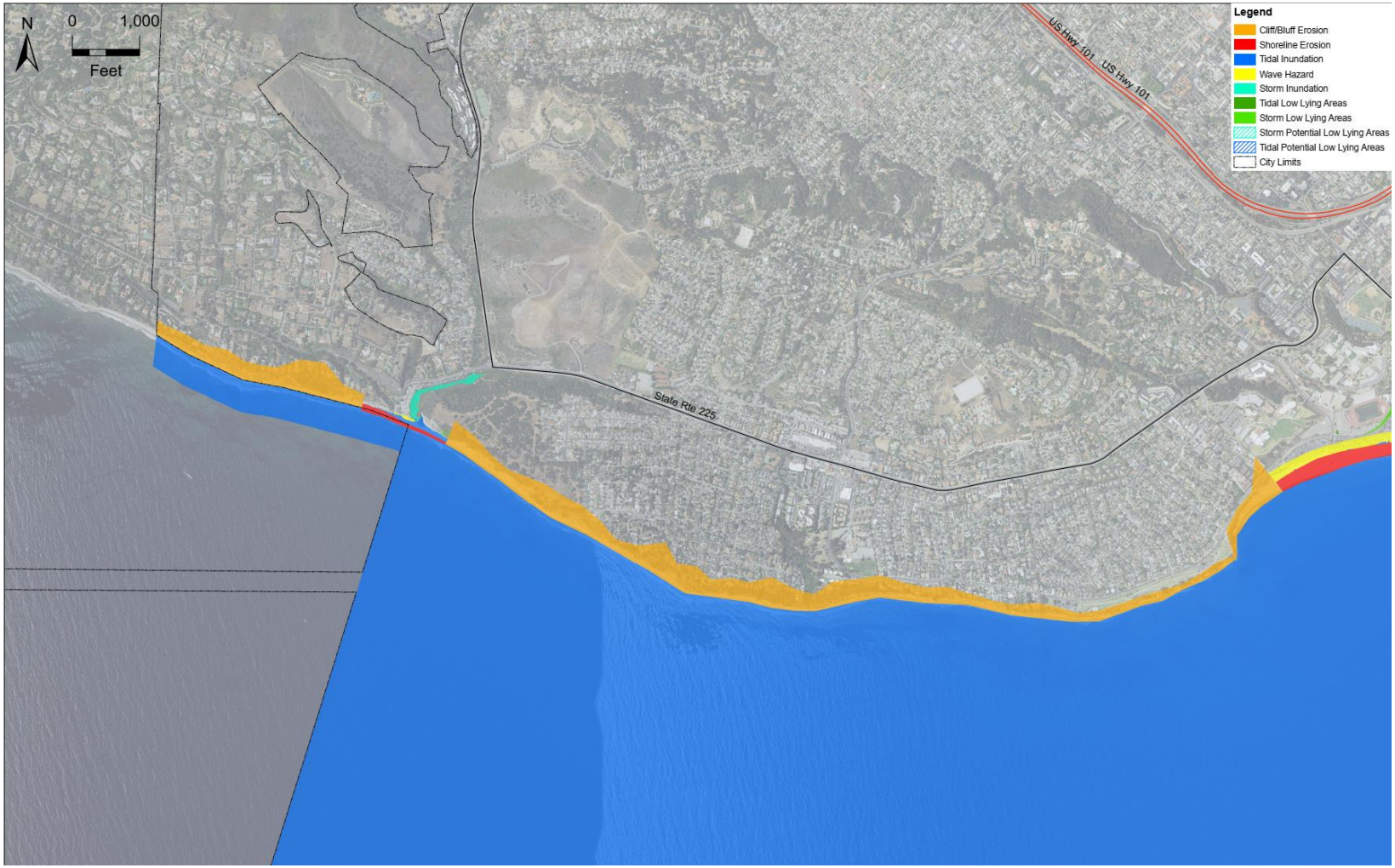
2060 with 2.5 feet of Sea-level Rise

2100 with 5.7 feet of Sea-level Rise



Existing Conditions

2060 with 2.5 feet of Sea-level Rise



2100 with 5.7 feet of Sea-level Rise

Next Steps

Accomplished to date:

- Selection of sea-level rise scenarios
- Hazard mapping

In progress, to be presented in September:

- Vulnerability Assessment
  - Assets and infrastructure
  - Ecosystems
  - Economics

Subsequent steps:

- Adaptation Plan
- Policy development and Local Coastal Plan Amendment

2100 (5.7 ft of Sea-level Rise)

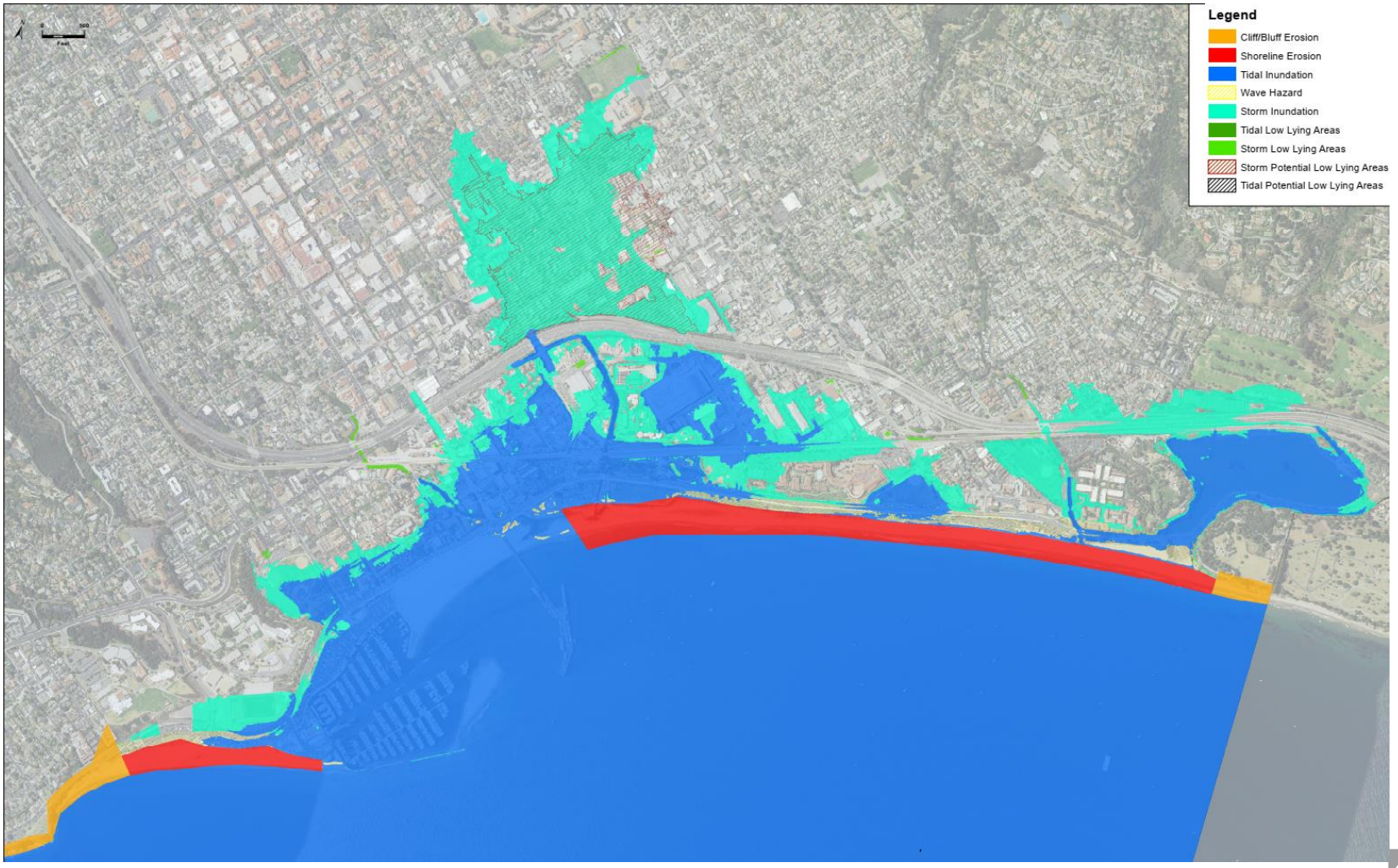
Hold-The-Line Management Scenario

2100 (5.7 ft of Sea-level Rise)

Let-it-Go Management Scenario

2100 (5.7 ft of Sea-level Rise)

Hold-The-Line Management Scenario



2100 (5.7 ft of Sea-level Rise)

Let-it-Go Management Scenario